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"OASIS" IN SPACE

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During the flight of the Soyuz 13 spacecraft (from 18 to 26 December 1973), newspapers reported on the Oazis-2 system installed on board the craft. What was the aim of the experiment?

Microorganisms are active participants in the recycling of matter on Earth. Therefore to them is drawn the attention of researchers developing life support systems for cosmonauts.

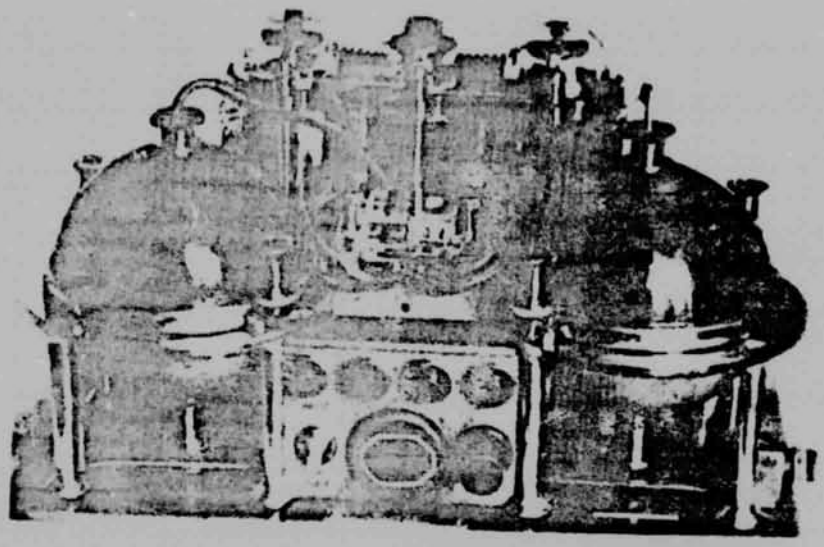
Of greatest interest are the hydrogen bacteria, which are classified in the group of chemolytotrophic organisms. The main source of carbon nutrition for them is carbon dioxide, and the energy source (electron "donor") is hydrogen. Another characteristic feature of this microorganisms is that they can grow from a wholly mineral medium. Incidentally, they (as well as urobacteria) behave as mixotrophes: they assimilate even organic compounds, by synthesizing cellular substances from them.

Willy-nilly the idea of the possibility of "combining" man and hydrogen bacteria suggests itself. This scheme can be represented roughly as follows.

The water that man excretes in the amount of about three liters a day goes into an electrolyzer, where it is decomposed into hydrogen and oxygen. Man can get back about 0.8 kg of oxygen per day. The hydrogen and the rest of the oxygen go into a hydrogen bacteria cultivator. Into it is also fed the carbon dioxide (about 1 kg a day) that man excretes.

In the cultivator biosynthesis occurs according to this reaction:

$$6H_2 + 2O_2 + CO_2 \rightarrow CH_2O + 5H_2O.$$



Oazis-2 experimental biological station developed at the Moldavian SSR Academy of Sciences

The compounds formed can become the basis for food.

Clearly, for the installation to function normally a certain dynamic equilibrium of continuously occurring processes must be maintained in it. And this is not so simple. On achieving equilibrium in laboratory conditions on Earth, we do not yet know what will happen in space. For example, weightlessness may be reflected in the behavior of the liquid, the character of the electrolysis, or the rate of cellular division.

The experimental system was built (see Figure) to answer such questions.

Two cylindrical fermentation units containing culture media were connected via a gas chamber. Electrolysis of water (liberation of H_2 and O_2) took place in one of the cylinders along with the development of hydrogen bacteria; in the other, urobacteria multiplied. The urobacteria, on absorbing the excess oxygen formed in electrolysis released carbon dioxide, supplying the hydrogen bacteria. This unit was first installed on board the Kosmos 368 artificial satellite and functioned in weightlessness for 144 hours. During this time the optical density -- from which the "harvest"

of bacteria was evaluated -- increased by more than nine times. Interestingly enough, it increased only six to seven times in the ground control.

But on Soyuz 13 a different system -- Oazis-2 -- was installed. Look at the photograph. In the foreground can be seen two spherical vessels within which are situated the separatory membranes. On Earth these vessels were filled with nutrient media for the hydrogen bacteria and the urobacteria. In the center, over the control panel, is the peristaltic pump. During the flight the cosmonauts periodically switched on the "Pump", feeding fresh nutrient medium from the vessels into the fermentation units. At the same time, from the fermentation units was sampled the bacterial suspension, which went into the same vessels, but from the other side of the membrane. The pump operated for a total of 12 hours during the flight and pumped through the fermentation units practically all the nutrient medium that had been prepared. The density of the bacterial mass rose by 30 times. In conditions of the ground control experiment the rise in the density of the suspension was much less.

Thus, this experiment showed the fundamental possibility of undertaking this technological process in space flight conditions.

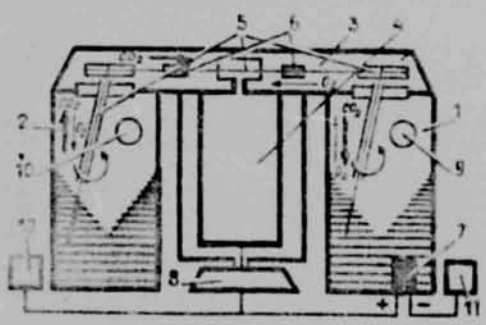


Figure. Two-component scheme of the experiment. Two cylindrical fermentation units 1 and 2 have a common gas chamber 3. Through magnetic clutch 8 and motor 4, by means of device 5, the culture medium is mixed with the gaseous components -- hydrogen and oxygen. The latter are formed at the electrodes 7 when voltage is fed to them. When the pressure in the gas loop reaches some limiting value, for example, 20 mm Hg, the

/Caption to figure, concluded/: electrolysis halts -- sensors 11 and 12 with microswitches come into play. Hydrogen bacteria during this time "eat up" the hydrogen and part of the oxygen. The remaining part of the oxygen is absorbed by the urobacteria, releasing instead carbon dioxide gas. When the hydrogen and oxygen pressure falls off, the sensors are retriggered, and electrolysis starts up again. In short, the system functions in the self-regulation mode. In conclusion, we can clarify: the urobacteria and the hydrogen bacteria are fed into the fermentation units via connecting pipes 9 and 10, and to prevent the liquid from going from one cylinder to the other, interceptors 6 are provided.